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Population abundance, density and diversity of antelope species in Pandam Wildlife Park, Plateau State, Nigeria

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Abstract: Habitat loss and fragmentation are heating deep into conservation areas like Wildlife Parks and this has posed a serious threat to wildlife population abundance and diversity. The fluctuations in population of fauna species are dependent on the quality of the habitat. Therefore, the population abundance, density and diversity of antelope species were investigated. Line transects (2 km each) were laid 1km apart in: savannah woodland-SW (n=4), riparian forest -RF (n=3) and swamp land-SL (n=3). The line transect method was used to identify antelopes during wet (July-October) and dry (December-March) seasons (2017-2019). Simpson's (D) and Shannon-Weiner (H') indices were estimated for herbivores. Data were analysed using descriptive statistics and ANOVA at α0.05. Four Antelopes were identified and Kobus kob was most dominant. Antelope abundance and mean population density increased from SL (18, 2.3) to SW (80, 10) and were higher in dry (70, 8.8) than wet (56, 7.0) season. Antelopes, highest D (0.7) and H' (1.6) were in SW, while least were in SL (D= 0.6, H'= 1.2). The savannah woodland favoured the antelopes and had influence on their abundance and diversity. Antelope species were almost not found in other habitats due to human activities within the park. The anthropogenic activities are fast entering into the core area of the park. Hence, the park management should take strategic measures to curb this fast-rising challenges.

Keywords: Pandam Wildlife Park, antelope, population abundance.

Introduction

Wildlife Parks (WP) protect the integrity of the natural environment and also serve as the cornerstone for biodiversity conservation. It is among sites for biodiversity conservation in Nigeria and the whole world. Wildlife Parks are the most feasible strategy to manage and conserve biodiversity (Thomas & Middleton 2003). Wildlife parks harbour most of our remaining forest vegetation and fauna species which play key roles in climate change, habitat structure, biodiversity conservation and ecotourism (Yager *et al.*, 2015; Odunlami & Ijeomah 2016; Maradana and Owk 2016). Forest ecosystems at all levels are highly productive areas and they are acknowledged to harbour a notable portion of global biological resources (Baraloto *et al*. 2013). According to Tyowua *et al.*, (2012) wildlife studies are considerably valued when assessment incorporates its habitat. However, the primary limiting component that affect wild animal population changes are the quality and size of the habitat. Antelope species like others have a sedentary and docile nature which makes them highly vulnerable to habitat degradation. Mammalian herbivores like antelopes promote economic growth, through tourist participation and other related activities (Ogunjemite *et al.*, 2010).

Plate (1): Male (a) and Female (b) Kob (*Kobus kob*) sighted in Pandam Wildlife Park

Unfortunately, there is a global decline in herbivores species which occurred mostly in our protected areas (Ogutu *et al.*, 2016). This is alarming as most protected areas are antropogenic in nature and could not keep their obligation (Henschel *et al.*, 2014).

The increase or decrease in the population density, diversity and abundance of wildlife species over time is dependent on the quality of the habitat and the level of human interference among other factors. Hence, an updated checklist of antelope species

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population abundance is necessary to enable park management and other stakeholders make effective plans and policy towards sustainable species conservation. The four sighted antelopes are presented in plate 1-4.

Plate (2): Male (a) and Female (b) Common/Grimms duiker (*Sylvicapra grimmia*) sighted in Pandam Wildlife Park.

Plate (3): Male (a) and Female (b) Red-flanked duiker (*Cephalophus rufilatus*) sighted in Pandam Wildlife Park.

Plate (4): Male (a) and Female (b) Bushbuck (*Tragelaphus scriptus*) sighted in Pandam Wildlife Park.

Materials and methods

The African Union (AU) pioneered the setting up of reserves, including Pandam Wildlife Park, Plateau State, Nigeria, which was established in 1972. Pandam Wildlife Park (PWP) is a swamp, and wooded Guinea-savannah habitat located in the North-central of Nigeria (8^{o} 35^{1} N and 8^{o} 55^{1} N and 8^{o} 00^{1} E and 10^{o} 00^{1} E) (Figure 1; Ezealor 2002**).** The PWP protects a forested area of 327.54 km^2, with an important water source (a Y- shaped lake been the major tributaries of River Benue) for much of the Qu'apam Local Government Area. The elevational range of the park(from 91 to 206 m above sea level) result in three diverse range of habitat (ranges). The Savannah-woodland dominated by *Parinari curatellifolia*, *Combretum nigricans*, and *Vitellaria paradoxa;* Swamp land *Mitragyna inermis*, *Acacia nilotica* and Riparian Forest mostly along the tributaries of the bank s of the Pandam Lake, dominated by *Vitex doniana*, *Erythrophleum suaveolens*, *Rauvolfia vomitoria*, *Prosopis africana* and *Elais guinensis*. The soil is ferruginous and lies over sedimentary rocks **(**Akosim *et al*., 2004**).**

The mean annual rainfall ranges from about 1000 to 1500 mm **(**Samson 2016**).** The annual mean temperature of the Park is 39ºC. The PWP is surrounded by areas of high human population density and intense agricultural practice. Human activities encroaching on the park have led to high levels of habitat degradation through unmanaged logging, charcoal production and livestock grazing. The perimeter wire fence erected at the early time of the park creation (1973), to help preserve the ecosystem, while protecting neighboring communities from damage caused by wildlife has been pull down.

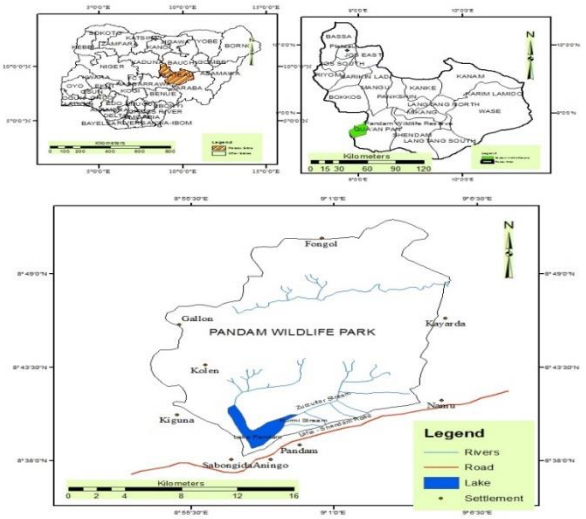

Figure (1): Map of Pandam Wildlife Park **Source**: Plateau State Ministry of Tourism, 2017.

Data collection procedure and analyses

Survey of mammalian herbivores (Antelopes) were adapted from the methods of Thomas *et al* (2010) and Akinsorotan (2017)**.** Line transect method was used to identify and estimate abundance and density/km^2 of antelope at (06:00-10:00 hrs and 15:00-19:00 hrs) aided with binoculars for 5 consecutive days monthly during wet (July-October) and dry (December-March) seasons in 2017 to 2019. The following data on any antelope individual sighted was recorded; the species, number, distance of walk (along the line transect), perpendicular and sighting distances. No survey was carried out during the raining days to minimize disturbance **(**Peres 2000; Lannoy *et al.*, 2003**).**

Antelope's population abundance, density and diversity

Abundance = Total number of individuals present (per range)

Density = Densities per range expressed as the number per km^2

$$\text{Density} = \frac{\text{Total number of species encountered}}{\text{Area of transect (/km}^2\text{)}} \quad (1)$$

Abundance indices were calculated using R version 4.0.0 (R-Core_Team, 2019) with the aid of the plyr package **(**Hadley 2011**)** and vegan package **(**Oksanen *et al.*, 2018**).** Rank-Abundance curves were drawn using Biodiversity R package **(Kindt & Coe 2005).**

Species encounter count was determined using the Cochran-Mantel-Haenszel test (M^2) as follows:

$$M^2 = \frac{[\sum_k (n_{11k} - \mu_{11k})]^2}{\sum_k \text{Var}(n_{11k})} \quad (2)$$

Where μ_{11k}= is the expected frequency of the *k*th.

K = constant Var(n_{11k})= nominal variables

Diversity indices such as Simpson (D) index and Shannon-Wiener (*H'*) index (Magurran, 2004), Eveness (E_H) and Margalef Index (*MI*) were determined for mammalian herbivores (antelope) as espressed as follows;

$$\lambda = \sum \frac{n_i(n_i-1)}{N(N-1)} \quad (3)$$

$$D^S = 1 - \sum \frac{n_i(n_i-1)}{N(N-1)} \quad (4)$$

Shannon-Wiener Index (H') – The index depends on species richness and evenness

$$H' = -\sum \left(\frac{n_i}{N} \times ln \frac{n_i}{N}\right) \quad (5)$$

Pilou evenness (*J***)** compares the actual diversity value

$$J = \frac{H'}{H_{max}} \quad (6)$$

$$EH = \frac{H'}{\ln S} \quad (7)$$

Margalef's index (*MI*) – The higher the index the greater the richness

$$MI = \frac{n-1}{lnN} \quad (8)$$

where *ni* is the number of individuals (or biomass) of each of the *i* species and *N* is the total number of individuals (or biomass) for the site.

Results

a. Antelope species composition across the habitats of Pandam Wildlife Park

A total of 126 individual mammalian herbivores (Antelopes) of four species belonging to the family Bovidae were recorded. This allied with IUCN (2009) that 91 out of 97 herbivores identified globally are Antelopes. Sixty-three percent (80) of antelope species were recorded in the savannah woodland (SW), 22.22% (28) were in the riparian forest (RF) and 14.29% (18) were in the swamp land (SL) (Table 1). Sightings (48.0%) were made in the SW habitat of the park, 30.0% sightings in the RF and 22.0% sightings in the SL, respectively (Figure 2). The result in figure 3 reveal that 62.0% sightings were made in dry season during the survey and 38.0% sightings were made in wet season.

b. Antelope population abundance and density per seasons in Pandam Wildlife Park

The result of rank-abundance curve and density of antelopes per season is presented in Figure 4 and 5; and Table 2. The species *Kobus kob* (Kk) ranked first in wet season of Pandam Wildlife Park with highest abundance/density of (24/ 3 km^2), while *Tragelaphus scriptus* was the least abundant with 8/ 1 km^2. The dry season survey indicated that Sylvicapra grimmia were the most abundant with higher density (24/ 3 km^2), while the least was *Cephalophus rufilatus* with the abundance/density of (10/1.3 km^2).

The population rank-abundance of *Kobus kob* was relatively high compared to other antelopes, but the density was very low compared to the findings of Oladipo *et al.*, (2019) in Kainji Lake National Park, Nigeria, but contradicts the report of Antelope Global Survey (SSC/ASG/IUCN), as compiled by East (1999), which label Kob "Vulnerable" in Nigeria. However, when viewed on a global scale, they may be vulnerable as the species is likely to be very rare elsewhere or outside the protected area **(**Oladipo *et al*, 2019**).** *Kobus kob* were observed in clusters of three (3) to five (5) individuals (Harem families); indicating that they are not solitary animals like the duikers. Estimation of the population abundance and diversity is vital to management and conservation of any given species even at local or international level. In the dry season survey, *Sylvicapra grimmia* (Sg) ranked first in PWP with higher abundance of (13), while *Cephalophus rufilatus* (Cr) with the abundance of 8 ranked third. The most abundant species was *Kobus kob* with (46) and a density of 5.75/Km^2, More so, the dry season survey had the higher density of 8.75/Km^2 (Table 2). Migration among antelopes is common, but factors that impact

negatively on their abundance are poaching, habitat degradation and livestock grazing (competition with especially cattle) **(**Jayeola *et al.* 2012; Oladipo 2001**).** More so, the species count at the various habitats and per seasons were independent. The population of large and small animals decreases with increasing human activities and habitat loss. However, *Kobus kob* and

Sylvicapra grimmia can maintain its populations under high habitat loss **(Lwanga 2006)** as it was evident in this finding. More so, fauna species with broader habitat preference and distribution tend to be more associated with riparian forest habitat **(Downs *et al.* 2016)**.

Table (1): Antelope species composition across habitats and season of Pandam Wildlife Park

Common name	Scientific name	Family	Habitats			Total	Season		Total
			SW: ds/ws	RF: ds/ws	SL: ds/ws		Dry	Wet	
Red-flanked duiker	*Cephalophus rufilatus* (Gray, 1842)	Bovidae	12 (8) (4)	4 (1) (3)	2 (1) (1)	18	10	8	18
Kob	*Kobus kob* (Erxleben, 1777)	Bovidae	30 (12) (18)	10 (8) (2)	6 (2) (4)	46	22	24	46
Common duiker	*Sylvicapra grimmia* (Linnaeus, 1758)	Bovidae	25 (13) (12)	8 (5) (3)	7 (6) (1)	40	24	16	40
Bushbuck	*Tragelaphus scriptus*. (Pallas, 1766)	Bovidae	13 (8) (5)	6 (4) (2)	3 (2) (1)	22	14	8	22
% Composition			**80 (63.49)**	**28 (22.22)**	**18 (14.29)**	**126**	**70 (55.56)**	**56 (44.44)**	**126**

SW = Savannah woodland; RF= Riparian Forest, SA = Swamp Area, ds = dry season and ws = wet season

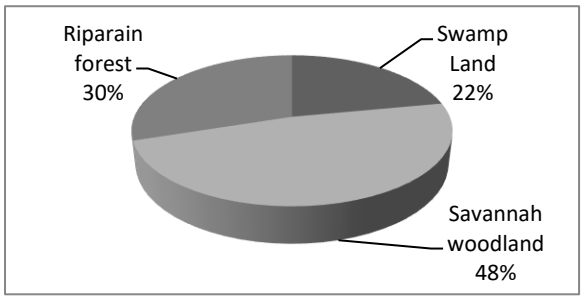

Figure (2): Antelope species sighting in percentages across the habitats of Pandam Wildlife Park.

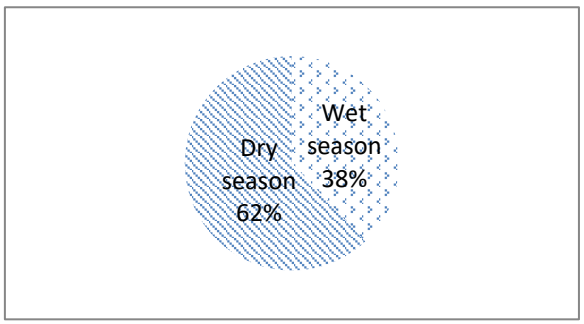

Figure (3): Antelope species sighting in percentages for seasons in Pandam Wildlife Park

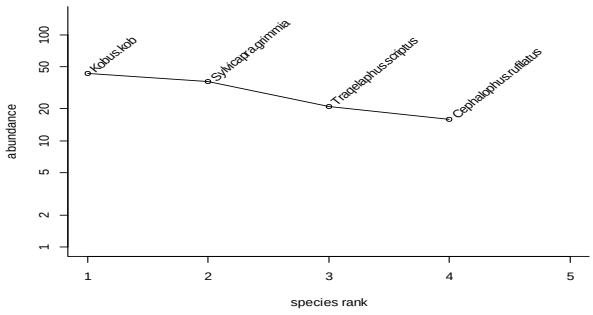

Figure (4): Overall Rank-Abundance Curve for Antelope species at wet season in Pandam Wildlife Park.

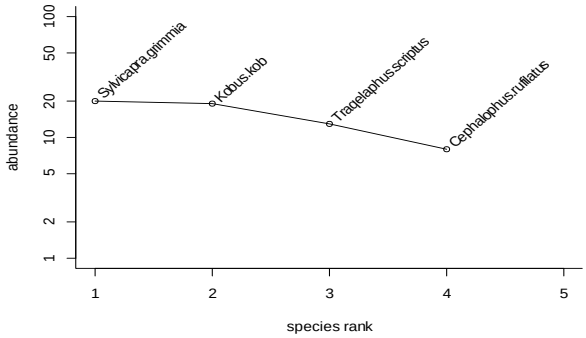

Figure (5): Overall Rank-Abundance Curve for Antelope species at dry season in Pandam Wildlife Park.

c. Diversity of Antelope across habitats in Pandam Wildlife Park

The result of Antelope species diversity and species count is presented in table 3 to 6. The Simpson's index (1-D) and Shannon-Wiener index (H') at Savannah Woodland (SW) I-D=0.9 and H'=1.63 was higher across the habitats in the park, while the least was at SL (I-D = 0.70 and H'=1.28). In both seasons across the habitats; SW also had the higher I-D = 0.74 for the wet season and 0.74 for the dry season and H' (wet:1.37 and dry: 1.37), respectively. The least was also recorded in SL (I-D for wet: 0.61; dry: 0.63 and H' for wet was 1.15 and dry 1.17) respectively (Table 3 to 5). Taking both historic and current investigation into account, the transitional landscape within Pandam Wildlife Park (PWP) appears to support a low species diversity of antelopes, but closely similar to both savannah and some forest habitats in Nigeria. For example, Halidu *et al*. (2013) observed eight (8) species of antelopes in Kainji Lake National Park. The

habitat change in PWP may contain the extremes of the ecological condition under which true forest and savannah specialist can exist. The count of species across the habitats and seasons presented in (Table 6) indicated the value for M^2=1.84, df = 3 and P-Value=0.605 (not statistically different). The Cochran-Mantel-Mantel-Haenszel (M^2) test revealved that species count was independent of the habitats and seasons at P-value =0.605. This indicated that, the encounter rate of the four antelopes (*Tragelaphus scriptus, Kobus kob, Sylvicapra grimmia* and *Cephalophus rufilatus*) was similar regardless of the habitats and season. Though the species has become rare and vulnerable to extinction within the park.

Table (3): Diversity of Antelopes across habitats in Pandam Wildlife Park

Habitats	Savannah Woodland	Riparian Forest	Swamp Land
Margalef's Index	0.90	0.71	1.04
Shannon-Weiner Index	1.63	1.31	1.24
Simpson's Index	0.72	0.64	0.70
Pielou's Index	0.52	0.51	0.50

Table (4): Diversity of Antelopes per wet season in Pandam Wildlife Park

Habitats	Savannah Woodland	Riparian Forest	Swamp Land
Margalef's Index	1.30	0.82	1.54
Shannon-Weiner Index	1.37	1.22	1.15
Simpson's Index	0.74	0.66	0.61
Pielou's Index	0.53	0.48	0.44

Table (5) Diversity of Antelopes per dry season in Pandam Wildlife Park

Habitats	Savannah Woodland	Riparian Forest	Swamp Land
Margalef's Index	0.87	1.04	1.25
Shannon-Weiner Index	1.37	1.21	1.17
Simpson's Index	0.74	0.67	0.63
Pielou's Index	0.54	0.48	0.45

Table (6) Antelope species encountered during each season and per habitat

Habitats	Season	TS	KK	SG	CR
Savannah Woodland	Wet	5	18	12	4
	Dry	7	9	9	6
Riparian Forest	Wet	2	2	3	3
	Dry	4	8	5	1
Swamp Land	Wet	1	4	1	1
	Dry	2	2	6	1

Cochran-Mantel-Haenszel M^2 = 1.8425, df = 3, p-value = 0.6057

Note: Ts- *Tragelaphus scriptus*, Kk- *Kobus kob*, Sg- *Sylvicapra grimmia* and Cr- *Cephalophus rufilatus*).

Conclusion

Protected Areas and conservation sites require continuous update of information on status and trend of biodiversity including their population abundance and distribution. Four (4) antelope species (herbivores) were encountered with kobs having the highest abundance, density and diversity, being associated more with savannah woodland. Sighting of the species were made more during the dry season. However, increase and decrease in the populations of wild animal is dependent on the habitat quality and quantity among other factors.

We recommend that; Conservation education should be intensified to discourge habitat degradation through logging and indiscriminate burning of the park ecosystem as well as poaching activities inorder to restore the integrity of the park.

References

Akinsorotan, O.A. (2017). Status and determinants of large mammal occupancy in a Nigerianprotected area. PhD. Thesis. A thesis. Dept. of Wildlife ecology. University of Nottingham Trent. Xxxii + 100pp.

Akosim, C.; Mbaya, P.; Nyako, H.D. (2004). Evaluation of range condition and stocking rate of Jibiro grazing reserve, Adamawa State, Nigeria. *Journal of Arid Agriculture* 14: 35-39.

Baraloto, C.; Molto, Q.; Rabaud, S.; Hérault, B.; Valencia, R.; Blanc, L.; Fine, P.V.A.; Thompson, J. (2013). Rapid simultaneous estimation of above ground biomass and tree diversity across Neotropical forests: a comparison of field inventory methods, Bitropica 45:288-298.

Downs, C.T.; Ramesh, T.; Smith, E.A.D.; Smith, E.C.Y. (2016). The importance of microhabitat structure in maintaining forest mammal diversity and abundance in a mixed land-use mosaic, *Biodiversity and conservation*, 68-113.

Ezealor, H.U. (2002). Critical sites for conservation in Nigeria. Nigerian Conservation Foundation, Lagos, Nigeria. 46-47.

Hadley, W. (2011). The Split-Apply-Combine Strategy for Data Analysis. *Journal of Statistical Software, 40* (1), 1-29.

Henschel, P.; Coad, L.; Burton, C.; Chtaigner, B.; Dunn, A.; Macdonald, D.; Hunter, L.T.B. (2014). The lion in West Africa is critically endangered. *PLOS One* 9:1–11.

International Union for Conservation of Nature (IUCN). (2009). IUCN Red List of Threatened Species. Version 2009. 1, Gland, Switzerland.

Jayeola, O.A.; Onadek, S.A.; Mafiana, C.F.; Inah, E.I.; Okeyoyin, O.A. (2012). Past and Present Status of Kob (Kobus (Adenota) kob (Erxleben) in Nigeria. *International Journal of Biodiversity and Conservation*, 4, 197-205.

Kindt, R.; Coe, R. (2005). *Tree diversity analysis. A manual and software for common statistical methods for ecological and biodiversity studies.* Nairobi: World Agroforestry Centre (ICRAF).

Lannoy, L.; Gaidet, N.; Chardonnet, P.; Fangouinoveny, M. (2003). Abundance estimates of duikers through direct counts in a rainforest, Gabon. *African Journal of Ecology* 41:108–110.

Lwanga, J.S. (2006). The influence of forest variation and possible effects of poaching on duiker abundance at Ngogo, Kibale National Park, Uganda**.** *African Journal of Ecology 44*.2: https://doi.org/10.1111/j.1365-2028.2006.00629.x

Magurran, A.E. (2004). *Measuring biological diversity*. Oxford: Blackwell publishing.

Maradana, T.N.; Owk, A.K. (2016). Tree diversity, stand structure, and community composition of tropical forests in Eastern Ghats of Andhra Pradesh, India. *Journal of Asia-Pacific Biodiversity* 9: 328-334

Odunlami, S.S.; Ijeomah, H.M. (2016). Preference of recreational activities and Wildlife species by tourists in Yankari game reserve, Nigeria. *Int'l Journal of Agric. and Rural Dev.* 19.2: 2647 – 2652.

Ogunjemite, B.G.; Ashimi, T.A.; Okeyoyin, T. (2010). The Chimpanzee Community of German-Fort, and the potentials for the development of tourism-based management of Gashaka-Gumti National Park, Nigeria. *Journal of Sustained Development in Africa*, 12.4: 108- 112.

Ogutu, J.O.; Piepho, H.; Said, M.Y.; Ojwang, G.O.; Njino, L.W.; Kifugo, S.C.; Wargute, P.W. (2016). Extreme wildlife declines and concurrent increase in livestock numbers in Kenya: What are the causes? *PloS One* 11.9:0163249.

Oladipo, E.O. (2001). International Initiative on Biodiversity Conservation since 1992. In: Poopola, L and Oluwanna S.A. Eds. *Biodiversity Rainforest Ecosystem in Nigeria. FEPA-UNAAB Linkage Centre for Forest Conservation Biodiversity*. University of Agriculture Abeokuta, Abeokuta, 22-32.

Oladipo, O.S.; Folorunso, A.A.; Lewiska, L.F.; Lameed, G.A. (2019). Population density, diversity and abundance of Antelope species in Kainji Lake National Park, Nigeria, *Open Journal of Ecology*, 9:107-116.

Oksanen, J.; Blanchet, F.G.; Friendly, M.; Kindt, R.; Legendre, P.; McGlinn, D.; Wagner, H. (2018). Community Ecology Package. Retrieved from https://CRAN.R-project.org/package=vegan

Peres, C.A. (2000). Effects of subsistence hunting on vertebrate community structure in Amazonian Forest*; Conservation. Biology.* 14.1: 240-253.

Samson, A.D. (2016). Anthropogenic activities in Pandam Wildlife Park: Do breeding birds benefit from cattle grazing and poaching? Rufford Small Grants Report: www.rufford.org 3-22pp.

Thomas, L.; Middleton, J. (2003). Guidelines for management planning of Protected Areas. IUCN Gland, Switzerland and Cambridge, UK. https://portals.iucn.org/library/efiles/edocs/PAG-010.pdf.

Thomas, L.; Buckland, S.T.; Rexstad, E.A.; Laake, J.L.; Strindberg, S.; Hedley, S.L.; Bishop, J.R.; Marques, T.A.; Burnham, K.P. (2010). Distance software: design and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology* 47.1:5-14.

Tyowua, B.T.; Agbelusi, E.A.; Oyeleke, O.O. (2012). Evaluation of roan antelope habitats (*Hippotragus equinus*, desmarest 1804) in Kainji Lake National Park, Nigeria, *Global Advanced Research Journal of Environmental Science and Toxicology* 1.6:166-171.

Yager, G.O.; Alarape, A.A.; Gideon, P.K. (2015). Assessment of recreational potentials of Makurdi Zoological Garden, Benue State, Nigeria. Nigeria, *Journal of Agriculture, food and Environment* 11.3: 80-86.